REMARKS

These amendments and remarks are being filed in response to the final Office Action dated June 12, 2006. For the following reasons this application should be allowed and the case passed to issue.

No new matter is introduced by this amendment. The amendments to claims 1 and 7-9 are supported by Table 9 of the Specification on page 29; and page 8, lines 15-18 and 25-30.

Claims 1, 3, and 5-30 are pending in this application. Claims 1, 3, and 5-30 are rejected. Claims 1, 7, 8, and 9 have been amended. Claims 2 and 4 were previously canceled.

Information Disclosure Statement

The Office Action acknowledged receipt and consideration of most of the references in the Information Disclosure Statement filed April 18, 2005. The Examiner apparently inadvertently failed to initial the last reference on the PTO-1449. Applicants respectfully request the Examiner consider copending U.S. Patent Application No. 10/300,590 filed November 21, 2002. For the Examiner's convenience a copy of the initialed PTO-1449 highlighting the uninitialed listing is attached to this response. Applicants respectfully request the Examiner consider all the references cited on the PTO-1449 and include a fully initialed copy of the PTO-1449 with the next official action.

Claim Rejections Under 35 U.S.C. § 103

Claims 1, 3-5, 7, 10, 16, 19, 25, and 28 were rejected under 35 U.S.C. 35 § 103(a) as obvious over Brothers (U.S. Pat. No. 6,328,009) in view of Takemura et al. (U.S. Pat. No. 6,224,688) (Takemura et al. `688).

Claims 1, 3, 5, 7, 13, 25, and 28 were rejected under 35 U.S.C. 35 § 103(a) as obvious over Faville et al. (U.S. Pat. No. 5,979,383) in view of Takemura et al. `688.

Claims 1, 3, 5, 7, 10, 22, 25, and 28 were rejected under 35 U.S.C. 35 § 103(a) as obvious over Bando (JP63-185917) in view of Takemura et al. `688.

These rejections are traversed, and reconsideration and withdrawal thereof respectfully requested. The following is a comparison between the invention as claimed and the cited prior art.

The Examiner averred that Brothers, Faville et al., and Bando disclose full type rolling bearings formed of an outer ring, an inner ring, and rollers. The Examiner acknowledged that Brothers, Faville et al., and Bando do not disclose that at least one of the outer ring, roller shaft, and bearing elements are made of steel and has a carbonitrided surface layer and an austenite crystal grain size number greater than 10. The Examiner relied on the teaching of Takemura et al. `688 of rolling bearings that have a carbonitrided layer and a crystal grain size greater than 11 to assert that it would have been obvious to use the steel of Takemura et al. `688 in the rolling bearings of Brothers, Faville et al., and Bando to achieve long life and high reliability. The Examiner further asserted that Takemura et al. (U.S. Pat. No. 6,440,232) (Takemura et al. `232) disclose the inherent manufacturing steps of carbonitriding (Fig. 3A). Furthermore, the Examiner maintained that Takemura et al. `232 disclose heating to 830°C, and that Takemura et al. `109 teach a hydrogen content in carbonitrided material of not more than 0.1 ppm.

Brothers, Faville et al, and Bando, and Takemura et al. `688, whether taken alone, or in combination, do not suggest the claimed full-type rolling bearing, and roller cam follower of an engine, because these references do not suggest at least one of the outer ring, inner ring and rollers or outer ring, roller shaft and bearing elements that has a hydrogen content of at most 0.5 ppm, has a carbonitrided layer in its surface layer, and the austenite crystal grain size number of the surface layer is greater than 10, wherein after at least one of the outer ring, inner ring and rollers is carbonitrided at a carbonitriding temperature equal to or higher than the A1 transformation

temperature, the at least one of the outer ring, inner ring and rollers is cooled to a temperature lower than the A1 transformation temperature and then heated to a quenching temperature of 790°C - 815°C and thereby quenched, as required by claims 1 or 7.

Takemura et al. `232 shows in Fig. 3A a method of thermal treatment similar to the method of thermal treatment of the present invention, however, the heating hardening temperature of Takemura et al. `232 is in the range of 830 - 870°C.

Takemura et al. `232 start quenching at a different temperature than the instant invention. Takemura et al. `232 start quenching in the range of 830 - 870°C, while the quenching temperature according to the present invention is 790° - 815°C. If the same material is quenched at both ranges, the material that starts quenching at the higher temperature range retains austenite having a larger grain size. Accordingly, Takemura et al. `232 provides retained austenite having a grain size corresponding to the range of 830 - 870°C, and hence, smaller than grain size 10. In contrast thereto, the present invention cools carbonitrided steel to a temperature lower than an A1 transformation point to reset (or remove) austenite grains generated in carbonitriding and starts to quench the steel at a low temperature range of 790° - 815°C, which provides austenite grains having a size corresponding to 790° - 815°C and hence falling within a range exceeding a grain size number of 10. The other cited references do not disclose the 790° - 815°C quenching temperature. Thus, claims 1 and 7 are distinguishable over the cited references.

Claims 1 and 7 are further distinguishable because the cited references do not suggest at least one of the outer ring, inner ring and rollers or outer ring, roller shaft and bearing elements that have a hydrogen content of at most 0.5 ppm. The Examiner maintains that the hydrogen content is disclosed by Takemura et al. `109. Takemura et al. `109 discloses:

> During carburizing or carbonitriding, diffusive hydrogen penetrates into the interior of the material. However, the material which has been carburized or

> carbonitrided can be heated in a vacuum furnace to reduce the content of diffusive hydrogen in the material to not more than 0.1 ppm and hence enhance the brittleness thereof.

(Column 10, lines 18-23). Takemura et al. `109 clearly teaches that the above content of hydrogen is the content of **diffusive hydrogen**. On the contrary, in the present invention, the content of hydrogen is the content of **non-diffusive hydrogen**, as disclosed on page 30, lines 29-33 of the Specification. Thus, Takemura et al. `109 does not suggest the claimed hydrogen content.

The cited reference do not suggest the unexpected improvements obtained in crystal grain size, Charpy impact, fracture stress, and relative rolling fatigue life, as shown in Table 9 of the present specification, obtained by samples having the claimed secondary quenching temperature and hydrogen content (*see* samples B and C).

Claim 6 was rejected under 35 U.S.C. 35 § 103(a) as obvious over Brothers in view of Takemura et al. `688 and further in view of Yoshida et al. (U.S. Pat. No. 5,803,993). This rejection is traversed, and reconsideration and withdrawal thereof respectfully requested.

The Examiner acknowledged that Brothers does not disclose a compression residual stress of at least 500 MPa. The Examiner relied on the teaching of Yoshida et al. of outer rings of constant velocity joints having a compression residual strength of 850 MPa to assert that it would have been obvious to modify the system of Brothers by providing a residual stress of at least 850 MPa in order to raise the fatigue strength of the device.

Brothers, Takemura et al. `688, and Yoshida et al., whether taken in combination or alone, do not suggest the claimed full-type rolling bearing because Yoshida et al. do not cure the deficiencies of Brothers and Takemura et al. `688. Yoshida et al. do not suggest at least one of the outer ring, inner ring and rollers a hydrogen content of at most 0.5 ppm, has a carbonitrided

layer in its surface layer, and the austenite crystal grain size number of the surface layer is greater than 10, wherein after at least one of the outer ring, inner ring and rollers is carbonitrided at a carbonitriding temperature equal to or higher than the A1 transformation temperature, the at least one of the outer ring, inner ring and rollers is cooled to a temperature lower than the A1 transformation temperature and then heated to a quenching temperature of 790°C - 815°C and thereby quenched, as required by claim 1.

Claims 8, 11, 17, 20, 26, and 29 were rejected under 35 U.S.C. 35 § 103(a) as obvious over Brothers in view of Hirakawa et al. (U.S. Pat. No. 6,012,851), and further in view of Kim et al. (*Journal of Heat Treat.*).

Claims 8, 14, 26, and 29 were rejected under 35 U.S.C. 35 § 103(a) as obvious over Faville et al. in view of Hirakawa et al., and further in view of Kim et al. (*Journal of Heat Treat.*).

Claims 8, 11, 23, 26, and 29 were rejected under 35 U.S.C. 35 § 103(a) as obvious over Bando in view of Hirakawa et al., and further in view of Kim et al. (*Journal of Heat Treat.*).

These rejections are traversed, and reconsideration and withdrawal thereof respectfully requested.

The Examiner acknowledged that Brothers, Faville et al., and Bando do not disclose that at least one of the outer ring, roller shaft, and bearing elements has a carbonitrided layer and fracture stress of at least 2650 MPa. The Examiner relied on the teaching of Hirakawa et al. of rolling bearings that have a carbonitrided layer and the teaching of Kim et al. that carbonitrided steel can have a fracture stress of 3220 MPa to assert that it would have been obvious to provide a carbonitrided layer to improve physical properties and thereby enhance longevity of the device.

Brothers, Faville et al, Bando, Hirakawa et al., and Kim et al., whether taken alone, or in combination, do not suggest the claimed roller cam follower of an engine, because these references do not suggest at least one of the outer ring, roller shaft, and bearing elements has a hydrogen content of at most 0.5 ppm, has a carbonitrided layer in its surface layer, and the austenite crystal grain size number of the surface layer is greater than 10, wherein after at least one of the outer ring, inner ring and rollers is carbonitrided at a carbonitriding temperature equal to or higher than the A1 transformation temperature, the at least one of the outer ring, inner ring and rollers is cooled to a temperature lower than the A1 transformation temperature and then heated to a quenching temperature of 790°C - 815°C and thereby quenched, as required by claim 8, as explained with regards to claims 1 and 7 above.

In addition, Brothers, Faville et al., Bando, Hirakawa et al., and Kim et al. further do not suggest a fracture stress of at least 2650 MPa, as required by claim 8. The steel types taught by Hirakawa et al. are different from those disclosed by Kim et al. Thus, there is no suggestion that the steel types taught by Hirakawa et al. would have the claimed fracture stress. Furthermore, there is no motivation to substitute the steel of Kim et al. for the steel of Hirakawa et al., as Kim et al. do not disclose the steel is suitable for use in a roller cam follower of an engine.

The cited reference do not suggest the unexpected improvement obtained in crystal grain size, Charpy impact, and relative rolling fatigue life, as shown in Table 9 of the present specification, obtained by samples having the claimed secondary quenching temperature, hydrogen content, and fracture stress (see samples B and C).

Claims 9, 12, 18, 21, 27, and 30 were rejected under 35 U.S.C. 35 § 103(a) as obvious over Brothers in view of Hirakawa et al. and further in view of Takemura et al. (U.S. Pat. No. 6,342,109) (Takemura et al. `109).

Claims 9, 15, 27, and 30 were rejected under 35 U.S.C. 35 § 103(a) as obvious over Faville et al. in view of Hirakawa et al., and further in view of Takemura et al. `109.

Claims 9, 12, 24, 27, and 30 were rejected under 35 U.S.C. 35 § 103(a) as obvious over Bando in view of Hirakawa et al., and further in view of Takemura et al. `109.

The Examiner acknowledged that Brothers, Faville et al., and Bando do not disclose that at least one of the outer ring, roller shaft, and bearing elements has a carbonitrided layer and hydrogen content of at most 0.5 ppm. The Examiner relied on the teaching of Takemura et al. `109 of keeping hydrogen content to not more than 0.1 ppm in order to enhance brittleness.

Brothers, Faville et al, Bando, Hirakawa et al., and Takemura et al. `109, whether taken alone, or in combination, do not suggest the claimed roller cam follower of an engine, because these references do not suggest at least one of the outer ring, roller shaft and bearing elements has a carbonitrided layer in its surface layer, and the austenite crystal grain size number of the surface layer is greater than 10, wherein after at least one of the outer ring, roller shaft and bearing elements is carbonitrided at a carbonitriding temperature equal to or higher than the A1 transformation temperature, the at least one of the outer ring, inner ring and rollers is cooled to a temperature lower than the A1 transformation temperature and then heated to a quenching temperature of 790°C - 815°C and thereby quenched, as required by claim 9, as explained with regards to claims 1 and 7 above.

In addition, Brothers, Faville et al., Bando, Hirakawa et al., and Takemura et al. `109 further do not suggest a hydrogen content of at most 0.5 ppm, as required by claim 9. The steel types taught by Hirakawa et al. are different from those disclosed by Takemura et al. `109. For example, Takemura et al. `109 disclose a steel requiring 2.0 to 9.0 wt % Cr. Thus, there is no suggestion that the steel types taught by Hirakawa et al. would have the claimed hydrogen

content. Furthermore, there is no motivation to substitute the steel of Takemura et al. `109, with its costly high chromium content, for the steel of Hirakawa et al.

Furthermore, as explained above with regards to claims 1 and 7, Takemura et al. `109 clearly teaches that the content of hydrogen is the content of **diffusive hydrogen**. On the contrary, in the present invention, the content of hydrogen is the content of **non-diffusive hydrogen**, as disclosed on page 30, lines 29-33 of the Specification. Thus, Takemura et al. `109 does not suggest the claimed hydrogen content.

The cited reference do not suggest the unexpected improvement obtained in crystal grain size, Charpy impact, fracture stress, and relative rolling fatigue life, as shown in Table 9 of the present specification, obtained by samples having the claimed secondary quenching temperature and hydrogen content (*see* samples B and C).

The dependent claims are allowable for at least the same reasons as the independent claims and are further distinguishable over the cited references.

In view of the above remarks, Applicants submit that this application should be allowed and the case passed to issue. If there are any questions regarding this Amendment or the application in general, a telephone call to the undersigned would be appreciated to expedite the prosecution of the application.

To the extent necessary, a petition for an extension of time under 37 C.F.R. § 1.136 is hereby made. Please charge any shortage in fees due in connection with the filing of this paper, including extension of time fees, to Deposit Account 500417 and please credit any excess fees to such deposit account.

Respectfully submitted,

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